What's the Weather Forecast?

Rain or Shine?

Don Hillger and Garry Toth

As a follow-on to previous articles about weather instruments as seen on postage stamps, this article features both instruments to measure precipitation and instruments to record sunshine. The two types of measurements are at opposite ends of the weather spectrum. The forecast may be for rain or snow or for a sunny day with few or no clouds. In either case, rain or shine, the meteorologist is interested in quantitative measurements. Both the rainfall (or snowfall) amount and coverage and the sunshine intensity and duration are needed for a complete understanding of the short-term weather as well as the longer-term climate of any area.

Let's start with some meteorology basics. Anything that falls from the sky is technically called a "meteor" with rain and snow therefore being "hydro-meteors." This is the origin of the word "meteorology" which for the typical nonscientist is an unusual name for the study of weather. Some people expect meteorologists to be knowledgeable about the well-known extra-atmospheric meteor, a stony mass from outer space that may burn up completely in the atmosphere or may strike the ground; in the latter case they are called meteorites. However, the meteorologist's realm is the atmosphere, a relatively thin layer above the earth's surface in which weather "happens." The atmosphere contains the moisture necessary to form rain and snow that falls to the surface.

The goal of precipitation measuring instruments (rain gauges and snow gauges) is to measure the amount of water that falls out of the atmosphere onto the surface. It is important to note that the reverse process also exists in which moisture flows from the surface to the atmosphere in the form of water vapor through evaporation from land and water surfaces, and transpiration from plant life. The processes of rainfall and evaporation/transpiration are major components of the atmospheric water cycle.

Traditional Rain Gauge
Angola (*Scott* 862)

Much of the precipitation falling on the earth's surface goes unmeasured due to the small number of rain or snow gauges employed over most terrestrial surfaces. Over the vast oceans, there are even fewer meteorological instruments. Overall surface-based precipitation measuring networks cover only a small fraction of the earth's surface.

Another problem is that even over land, the spatial density of rain and snow gauges is generally small compared to the high spatial variability of precipitation amounts. A few higher-density networks do exist. They are better at characterizing the true precipitation arriving at the surface than the lower density networks.

Rain Gauges

Precipitation gauges are generally of standard types with some design differences from country to country depending on their climatic regimes. The standard rain gauge in the U.S. is a cylinder-within-a-cylinder design. The outside cylinder has an eight-inch diameter opening to catch the rainfall. A funnel then collects the rain and directs it to the inside cylinder which is one-tenth the area of the outside cylinder. This effectively amplifies the rain catch by a factor of ten for easier reading. The inside cylinder can overflow into the outside cylinder if the rain is heavy. The relatively high walls of the rain

Tipping-Bucket Rain Gauge
Canada (*Scott* 481)

gauge opening are meant to keep rain from splashing out of the gauge. This type of gauge requires a human observer to read the gauge, and reset/empty it, at regular intervals of time (Angola, *Scott* 862).

Rainfall is generally a depth measurement, either in decimal inches (in the U.S.) or millimeters (elsewhere in the world). There is evidence that the size of the rain gauge has little effect on the measured rainfall. The U.S. rain gauge sits on a stand so that the funnel's rim is one meter above the ground.

Rain gauges are a common element on many stamps with meteorological themes. Rain gauges are major elements on stamps issued by Cuba (1971/*Scott* 1591); Mozambique (1989/*Scott* 1103); Uganda (1993/*Scott* 1195), in addition to the Angola stamp mentioned above.

Automatically-recording rain gauges also exist and are featured on a limited number of stamps. One such stamp was issued by Canada (1968/*Scott* 481) showing a tipping-bucket rain gauge in which small amounts of water fill and then pour out of two small "buckets" found at either end of a rocking arm. The arm tips back and forth as one bucket and then the other fills and drains. The number of tips is used to determine the amount of rainfall.

A recording rain gauge is also shown on a stamp issued by Upper Volta (1964/*Scott* 130). In this case the device takes a form closer to that of a recording barometer (barograph), but with a funnel for collecting rain.

Recording Rain Gauge
Upper Volta (*Scott* 130)

Rain gauges as much smaller elements of the design appear on stamps issued by Belize (1991/*Scott* 972); Jersey (1982/*Scott* 294); Malagasy (1967/*Scott* 404, and 1973/*Scott* C116); Namibia (1991/*Scott* 693); Philippines (1965/*Scott* 922-924, and 1970/*Scott* 1069); Russia (1961/*Scott* 2495); Sri Lanka (1998/*Scott* 1234); and Vanuatu (1992/*Scott* 565).

The wind has a major effect on the measurement of precipitation. Generally, as the wind increases, the precipitation caught by the gauge decreases. This effect must be compensated for by gauge design through various techniques to reduce the wind effect. The usual technique is to dampen the wind around them through the use of constructs known as "wind shields" or "wind screens." Interestingly, the same shared terminology is used for the frontal glass in an automobile, called a wind shield in the U.S. and a wind screen in the United Kingdom. However, the terminology as applied to the rain gauge is not nearly as geographically distinct. Generally, either solid cone (Nipher) wind screens or slatted or fence-type (Alter-type) wind screens are employed. Both of these reduce the effect of wind to increase the accumulated rainfall to more closely match that for nonwindy conditions.

The Alter-type wind screen is seen on many stamps. It is named after J. Cecil Alter who in the 1930s worked for the U.S. Weather Bureau (now National Weather Service) in Salt Lake City, Utah. Nice representations of this type of wind screen are shown on stamps issued by Afghanistan (1963/*Scott* 645-646, C46, C50) and People's Republic of China (1959/*Scott* 460). Other wind screens are

Rain Gauge With Wind Screen
Afghanistan (*Scott* C50)

Ancient Rain Gauge
South Korea (*Scott* 1459)

shown on stamps issued by Falkland Island Dependencies (1980/*Scott* 1L50, and 1985/*Scott* 1L50 reissue). These solid-type screens are probably of the Nipher type. This type of gauge was developed in Canada to compensate for the wind effect in snow conditions.

Ancient rain gauges are shown on a stamp and a souvenir sheet issued by South Korea (1961/*Scott* 321 and 321a, and 1987/*Scott* 1459). The stone foundation rain gauges shown in these items date from the Sejong Period to the Chosun Dynasty (around 1450 AD).

What comes down as precipitation eventually goes back to the atmosphere as water vapor through the process of evaporation. Evaporation is the transfer of water vapor from the earth to the atmosphere, completing the water cycle. Evaporation requires energy. This energy in effect flows from the earth's surface to the atmosphere with the water vapor and is known as latent heat.

Another form of energy, the energy we can "feel," is known as sensible heat and can also flow from the surface to the atmosphere, or vice-versa. For example, the sun can heat the ground which in turn heats the air. Evaporation is the transfer of water vapor from the earth to the atmosphere completing the water cycle. In the case of latent heat, water vapor takes energy with it. It is important to note that this energy will be released into the atmosphere when water vapor condenses back into water drops. Most evaporation occurs from water surfaces (lakes and oceans). Over terrestrial surfaces, evapotranspiration from plants is the most important source of water vapor for the atmosphere.

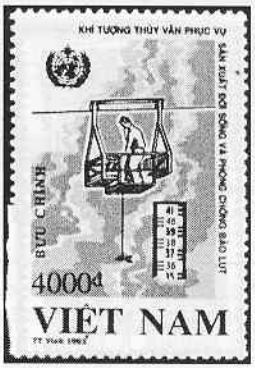
Evaporation pans are used to quantify

Evaporation Pan
Uganda (*Scott* 1195)

the evaporation of water vapor by exposing a large area of water to the elements and measuring the loss of water that takes place in a given time. The rainfall measured at a nearby gauge needs to be taken into consideration when measuring the net water loss or gain from the pan before finally determining the evaporation. Evaporation pans are shown on a very limited number of philatelic items: a stamp issued by Belize (1991/*Scott* 972), by Uganda (1993/*Scott* 1195), and a stamped envelope issued by Romania in 1984. These pans are generally fairly large in order to give sufficient area for evaporation, but the construction of evaporation pans and the ways that the evaporation is measured are diverse.

Rainfall varies widely both spatially and temporally. However, the amount of rainfall is an important measure of the ability of the land to support crops and therefore people. Mean precipitation maps can be produced from rainfall measurements, generally showing the amount of rain on average that falls in a given time, such as one year. Examples of maps with precipitation contours are shown on stamps of Grenada (1983/*Scott* 1156) and Upper Volta (1963/*Scott* 107). On the lat-

Precipitation Map
Upper Volta (*Scott* 107)



Water-depth Gauge
Viet Nam (*Scott* 2339)

ter stamp the precipitation contours are clearly given in millimeters.

In addition, precipitation over a large area can be indirectly estimated by the large amount of water that flows back to the ocean through streams and rivers. The water in streams and rivers is often gauged to determine the flow rate. Often that flow rate is directly related to the water depth in those water courses. Water-depth gauges are shown on stamps issued by Albania (1966/*Scott* 954 and 1969/*Scott* (1209); Malagasy (1967/*Scott* 404); Poland (1990/*Scott* 2977); and Viet Nam (1992/*Scott* 2339). These water-depth gauges typically measure the water level above some mean or minimum water depth established through longer-term water-depth records.

A unique set of four water-depth gauges is shown in the margin of a souvenir sheet issued by Hungary (1965/*Scott* B253). Those gauges are distributed along the Danube River with increasing water depths farther down stream. These water-depth gauges are calibrated in millimeters. Then there is a different type of water-depth gauge, one calibrated in years, featured on a stamp issued by Nigeria (1967/*Scott* 208). This stamp shows a pier extending into either a river or a lake with high water-depth record years indicated on a piling. It appears that 1955 was the high water record year at this location.

High Water Recorded
Nigeria (*Scott* 208)

Measuring Snow Depth

Precipitation of course falls as snow as well as rain in many parts of the world. For example, much of the precipitation in mountainous regions falls in the form of snow which accumulates throughout the winter season and is then released as water as the snow melts in the spring. In addition, in mid-latitude regions most of the winter precipitation is in the form of snow, as is the majority of all precipitation in polar regions. Therefore the snowfall or the snowpack needs to be measured to determine the precipitation for these regions. Snow is measured either by rain gauges in which the snow melts, or by "snow boards" on which the unmelted snow accumulates, and whose depth can therefore be measured with a simple ruler.

Although no actual snow-depth gauges or snow boards have been found on postal items, measurements of snow-depth using the ruler approach are featured on two stamps. A stamp issued by Australian Antarctic Territory (1966/*Scott* L12) shows snow strata being measured. Similarly, a postal card issued by Romania in 1998 shows measurements of snow depth.

Recording Sunshine

Having covered the precipitation aspect of the weather, the opposite side of the weather coin would be lack of precipitation, or even the lack of clouds. Although solar radiation is present every day over most of the earth, the actual amount and intensity of direct sunshine reaching the earth's surface is important for agricultural and energy use reasons.

The recording of sunshine can be accomplished with instruments that measure either the duration and/or the intensity of solar radiation. The most common type of sunshine recorder is the "heliograph" which consists of a glass sphere mounted in a spherical bowl so that it focuses the

Sunshine Recorder
Namibia (*Scott* 691)

suns rays on a card held in a track. As the sun moves across the sky, a sharply-focused spot burns a track in the card recording the sunshine duration during the day; this is then read manually by the weather observer. A common type of heliograph is the Campbell-Stokes sunshine recorder.

Some very good representations of heliographs with glass spheres are shown on stamps issued by Austria (2001/*Scott* 1857); Guinea-Bissau (1990/*Scott* 890); Namibia (1991/*Scott* 691); Nigeria (2000/*Scott* 707); Uganda (2000/*Scott* 1702); and Russia (2003/*Scott* 6741 in the margin of a souvenir sheet). Much smaller and less obvious representations of heliographs are shown on stamps issued by Argentina (1965/*Scott* 769); Malagasy (1973/*Scott* C116); Namibia (1991/*Scott* 693); South Africa (1983/*Scott* 612); and the Turkish Republic of Northern Cyprus (1992/*Scott* 337).

Another type of sunshine recorder is the "actinometer." This device measures the heating power of solar radiation after it is scattered by the atmosphere and reflected by the earth's surface. So, unlike the heliograph, this device measures both direct and indirect solar radiation. Two

Solar Radiation Measured
Angola (*Scott* 861)

Pyranometer Detects Radiation
South Africa (*Scott* 612)

different types of actinometers are shown on stamps. The one on a stamp issued by Angola (1993/*Scott* 861) has two glass-like spheres connected to a base. The other one on a stamp issued by the German Democratic Republic (1968/*Scott* 982) looks more like a spectrograph that splits the visible solar energy into colors, probably to measure the energy at different wavelengths across the spectrum.

The next type of sunshine recorder is the "pyranometer." This device has a hemispheric glass dome to catch all radiation from the sun and sky. Inside the glass dome is a thermopile sensor to measure the radiation. Pyranometers are often used to measure energy over a broad wavelength spectrum. The part of the energy spectrum being measured is determined by the type of glass used in the hemispheric dome. Some pyranometers are designed to measure only the energy of visible light; others are for infrared energy; and yet others are for both the visible and infrared parts of the spectrum. Pyranometers are often employed in pairs to measure both parts of the solar spectrum, either visible and total energy, or visible and infrared energy separately. Pyranometers are shown on stamps of South Africa (1983/*Scott* 612) and Uganda (1993/*Scott* 1198).

Another use of paired pyranometers is to measure the albedo of the earth. The albedo is the percentage of solar energy reflected back into the atmosphere by the earth's surface or by clouds. A stamp issued by the Australian Antarctic Territory (1997/*Scott* L105) shows the use of upward and downward looking pyranometers to measure the albedo of sea ice. Typically snow, ice, and clouds have a high albedo, whereas darker land surfaces and liquid water have a lower albedo.

Finally, it should be noted that the use of the term heliograph is not only limited to sunshine recorders. A heliograph can also be an instrument that uses the sun as a signaling device. Such "signaling heliographs" are seen on stamps of Dahomey (1967/*Scott* J35a) and Mali (1965/*Scott* 76). The devices on both of these stamps are designed to use the sun rays, unlike some other devices incorrectly labeled "heliograph" that are merely mechanical signaling or semaphore telegraphs. Other devices that do not use the sun are not true heliographs in spite of their name.

In this article the emphasis has been on stamps and souvenir sheets. However, precipitation gauges and sunshine recorders are also seen on other types of philatelic items, such as postal stationery, cancels, FDC cachets, and other types of covers that have not been specifically mentioned in this article. Checklists of all the postal items mentioned, along with images of additional items that were not discussed here, can be found on the authors' Website: *<http://www.cira.colostate.edu/ramm/hillger/precipitation.htm>*, and *<http://www.cira.colostate.edu/ramm/hillger/sunshine.htm>*. If readers know of other postal items showing precipitation gauges or sunshine instruments, the authors would greatly appreciate learning about them.•

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Weather Balloons
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stamp (1966/*Scott* B799) showing a sounding balloon and a tracking theodolite used during the 1963-1965 Belgian Antarctic expedition. A set of three stamps issued by French Southern and Antarctic Territories (1957/*Scott* 8-10) shows a pilot balloon tracking theodolite being used. Romania issued a stamp and souvenir sheet (1948/*Scott* B415 and B416a) showing a balloon tracking theodolite and a pilot balloon. One has to look carefully at this stamp to identify these items since the principal feature of the stamp is a *DC-3* aircraft. Similarly, Romania also issued a postal card in 1998 with a theodolite and no balloon. This item was issued for the 100th anniversary of the 1898-1899 Belgica Antarctic expedition, and the cachet shows an expedition member, Georges Lecointe, "making a meteorological measurement" with what is probably a tracking theodolite.

In this article the emphasis has been on stamps, souvenir sheets, and postal stationery. However, weather balloons and radiosondes are also seen on many other types of philatelic items such as cancels and cachets on FDCs and other types of covers. A checklist and images of all the postal items mentioned, along with many additional postal items that are not discussed here, can be found on the authors' Website:
<http://www.cira.colostate.edu/ramm/hillger/wxballoon.htm>

If readers know of other postal items showing weather balloons and radiosondes, the authors would greatly appreciate learning about them.•

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Rain Gauge Correction

There was an error in the ancient rain gauge depicted in Hiller and Toth's article appearing on page 25 of the November-December 2005 issue of *Topical Time*.

This stamp was incorrectly identified as "Ancient Rain Gauge / South Korea (*Scott* 1459). It is instead a 1959 issue of the Peoples Republic of China (*Scott* 460) which shows a girl standing beside an Alter-type wind screen.

This 1987 South Korea stamp (*Scott* 1459) should have been used that depicts a stone foundation rain gauge that dates from the Sejong period of the Chosun Dynasty, circa 1450 A.D.

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